Improving Yield in Alfalfa Seed Stands with Balanced Fertilization

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Background

- In western Canada, there are about 70,000 ha grown for alfalfa seed at a value (including leaf-cutter bees) of approximately $60 million.
- In north-eastern Saskatchewan, alfalfa is an important forage crop grown for seed.
- About after 3 years, alfalfa can not maintain its original productivity, resulting in low seed yields in some fields (or in areas of the field).
- Weed infestation/competition results in substantial loss in seed yield and hay, and contamination of seed (economic loss in cleaning, lowers the certified seed grade and reduces the marketability of the seed).
- The low production could also be due to depletion of soil fertility, because alfalfa has high requirements for P, S, K and some micronutrients (such as B).
- Because of low seed yield and infestation of weeds, alfalfa seed fields are terminated, predominantly by tillage.
- Termination of stands by tillage increases the cost of production due to tillage, reseeding, and can result in substantial N loss and soil erosion.
- If one nutrient is deficient in soil, crop growth will be poor even if other nutrients are abundant, and this can affect the longevity of alfalfa stands (even if little effect on seed yield).
- Phosphorus improves root development. Sulphur is essential nutrient for N-fixing bacteria, and it affects both yield and quality of seed in legumes. Legumes have higher S requirements than grasses.
- Potassium stimulates fixation of N and decreases incidence of winter injury by increasing accumulation of carbohydrates in roots of legumes.
- In north-eastern Saskatchewan, many soils are deficient in S and P, and some sandy soils contain insufficient amounts of K for high crop yields.
- Most soils are adequately supplied with micronutrients and their deficiencies are rare. Boron deficiency is suspected on sandy soils low in organic matter.
- Under poor fertility, alfalfa can not compete with weeds. Improved soil fertility can make alfalfa out compete weeds, increase longevity of stands by several years and reduce reseeding frequency, and this will also reduce operational costs of production, prevent soil erosion and N losses, and increase productivity and quality of alfalfa.

Objective

To determine the influence of balanced fertilization on seed yield and longevity of alfalfa stands in north-eastern Saskatchewan (remember that nutrient requirements of alfalfa grown for hay are greater than alfalfa seed stands).

Materials and Methods

- Field experiments were initiated in 2000 on established alfalfa stands.
- Treatments included no fertilizer plus various combinations of fertilizers P, K and S or B at different sites (depending on the nutrient deficiency in soil).
- Fertilizers were surface-broadcast in mid to late April (early spring) on the same plots of every year from 2000 to 2007.
- For this area, mean annual precipitation is 425 mm, and growing season (May to August) precipitation is 244 mm. Precipitation from May to August in 2000, 2001, 2002, 2003, 2004, 2005, 2006 and 2007, respectively, was 247, 175, 110, 56, 295, 330, 208 and 309 mm at Star City (alfalfa hay/seed experiment), and 274, 185, 275, 87, 418, 395, 264 and 301 mm at Porcupine Plan (alfalfa seed experiment).
- Alfalfa at maturity was harvested for seed yield in October or November in every year. In a few experiments, alfalfa dry matter yield (DMY) was also taken twice: Cut 1 in late June-Early July and Cut 2 in late August-Early September.
- In addition, field survey trials were conducted to find reasons for poor alfalfa seed yields in various parts of the same farm fields or in adjoining farm fields.
- This included sq m sampling of “Good” and “Bad” areas for seed yield and available nutrients in soil and/or any subsoil problem.

Summary and Conclusions

- Results of field experiments in different years (with the exception of years with drought and/or early autumn frost) indicated that there was generally an increase in alfalfa seed and/or DMY from fertilization in some fields when soil had low levels of available nutrients. However, in 2006 and 2007 at Star City, seed yields tended to decrease while forage yields increased with many fertilizer treatments. There is no real explanation, but this could be due to additional/excessive growth of alfalfa, resulting in lodging and subsequently poor pollination for seed production in the fertilized treatments.
- Results of survey trials suggest that in some alfalfa seed fields, poor seed yields may be due to nutrient deficiencies and/or a soil fertility imbalance.
- If a soil is testing low (or deficient) in a nutrient and alfalfa growth is reduced, then it is suggested that alfalfa seed producers should plan to use fertilizer to apply an adequate amount of that nutrient lacking in the soil.
- However, even after conducting soil and plant tissue analyses, it is still difficult to predict accurately if a profitable alfalfa seed yield response to fertilization will occur, particularly when the soils are testing marginal in some nutrient levels.

- Therefore, if it is suspected that a nutrient is deficient in soil, that nutrient should be applied to a portion of the affected area of the field in marked test strip. Visual observations, along with measurements of yield from treated and untreated areas, should be undertaken to determine if a measurable yield response had occurred.
- In order to save money and optimize the use of fertilizers, alfalfa seed producers can use the following suggestions: Apply fertilizers in test strips to find out if there is any increase in alfalfa seed yield and only then consider fertilization of the whole field on a regular basis. If there is a plan in place to use fertilizers on the alfalfa seed field, leave some strips without fertilizers in the field to compare alfalfa seed yields with and without applied fertilizer.

Other Additional Suggestions

- ✓ Seed yield response to applied fertilizers is affected by:
- ✓ Soil test level of available nutrients in soil (very low/low; marginal).
- ✓ Soil type (texture, organic matter, pH, etc.).
- ✓ Precipitation (total and distribution) and other weather conditions (temperature, frost, etc.)
- ✓ Stand age, population.
- ✓ Fertilizer sources/types, time, method, formulation.
- ✓ Other management factors (residue; seed vs. hay).

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Table 1. Alfalfa seed yields with and without fertilizers at Star City, Saskatchewan.

Treatment	Seed yield (kg ha^{-1})					
	2000	2001	2003	2004	2006	2007
No Fert	359	16	44	39	495	485
PK	418	80	90	40	443	341
KS	466	56	52	36	424	441
PS	406	35	74	38	448	484
PKS	424	29	85	29	447	375
PKSB	427	35	77	19	426	372
SEM	19.9*	21.6^{ns}	8.6$^{0.10}$	7.6^{ns}	48^{ns}	48^{ns}

*, **, *** and ns refer to significant effects in ANOVA at $P \leq 0.05$, $P \leq 0.01$, $P \leq 0.001$ and not significant, respectively.

Table 2. Alfalfa forage yields with and without fertilizers at Star City, Saskatchewan.

Treatment	Forage Yield (kg ha^{-1})							
	2000	2001	2002	2003	2004	2005	2006	2007
No Fert	5051	2112	2528	1403	4304	5635	8758	9164
PK	4923	2486	3260	1788	5394	6209	8306	9313
KS	5926	2942	3584	1867	6354	7371	9407	9377
PS	5691	2050	3029	1948	6618	8113	9465	12369
PKS	6035	2754	3098	2299	7191	7907	8891	12015
PKSB	6147	2435	3188	2118	7067	7684	9498	11612
SEM	217**	373^{ns}	330^{ns}	161$^{0.10}$	342***	369**	294^{ns}	592**

•,*, **, *** and ns refer to significant treatment effects in ANOVA at $P \leq 0.10$, $P \leq 0.05$, $P \leq 0.01$, $P \leq 0.001$ and not significant, respectively.

Table 3. Alfalfa seed yields with and without fertilizers at Porcupine Plain, Saskatchewan.

Treatment	Seed yield (kg ha^{-1})				
	2000	2001	2003	2006	2007
No Fert	85	167	85	391	218
PK	76	119	68	517	265
KS	130	240	140	416	206
PS	128	263	115	494	290
PKS	107	205	122	448	271
PKSB	110	267	107	469	233
SEM	14.6***	31.8***	12.5*	29*	20*

*, **, *** and ns refer to significant effects in ANOVA at $P \leq 0.05$, $P \leq 0.01$, $P \leq 0.001$ and not significant, respectively.

Table 4. Alfalfa seed and straw yields with and without fertilizers at Hudson Bay and Valporaiso, Saskatchewan in 2001.

Treatment	Yield (kg ha^{-1})			
	Hudson Bay		Valporaiso	
	Seed	Straw	Seed	Straw
No Fert	58	1310	32	950
PK	94	1580	38	850
KS	85	1440	25	650
PS	102	1770	30	1020
PKS	157	1800	45	720
PKSB	92	1950	50	880
SEM	67^{ns}	305^{ns}	13^{ns}	132^{ns}

ns refers to not significant in ANOVA .

Table 5. Alfalfa seed yields with and without fertilizers at Valparaiso, Mellville and Carrot River Saskatchewan in 2000 and 2001.

Treatment	Seed Yield (kg ha^{-1})			
	Valparaiso 2000	Valparaiso 2001	Melville 2000	Carrot River 2001
	No P	No P	No PKS	No S
Unfertilized	217	127	340	18
	+ P	+ P	+ PKS	+ S
Fertilized	259	175	444	10
SEM	28^{ns}	14***		6.2^{ns}

*** and ns refer to significance in ANOVA at $P \leq 0.001$ and not significant, respectively.

Table 6. Alfalfa seed yields with and without fertilizers at Valparaiso and Carrot River Saskatchewan in 2001.

Treatment	Forage Yield (kg ha^{-1})	
	Valparaiso	Carrot River
	No P fertilizer applied	No S Fertilizer Applied
Unfertilized	1138	994
	P Fertilizer Applied	S Fertilizer Applied
Fertilized	1230	1870
SEM	14***	225***

*** refers to significance in ANOVA at $P \leq 0.001$.

Table 7. Alfalfa seed and straw yields (Bad vs. Good area survey) at various locations in northeastern Saskatchewan (1999 to 2007).

Area Harvested	Yield (kg ha^{-1})													
	Porcupine Plain				Hudson Bay						Valporaiso			
	1999		2001		2000		2001		2007		2000		2000	
	L. Howse [a]		E. Hollinaty [b]		D. Nikonetz [c]		D. Nikonetz		W. Drebit [d]		P. Roy (west) [e]		P. Roy (east) [f]	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Bad	60	1492	101	3399	41	1601	15	992	10	326	15	1010	74	1419
Good	201	3138	660	4450	387	4596	555	4052	489	4249	201	2273	136	2170
SEM	20*	193**	35***	126***	15***	191***	27***	109***	42**	254***	21**	114**	5***	124**

*, **, *** and ns refer to siginicant effects in ANOVA at $P \leq 0.05$, $P \leq 0.01$, $P \leq 0.001$ and not significant, respectively.

[a] Soil test 2.4 ppm P and 8.0 ppm SO_4-S.

[b] Low P.

[c] Soil test 3.0 ppm (bad) vs. 11.0 ppm (good) and large O.M. difference between bad and good.

[d] Soil test still too come.

[e] Soil test 4.5 ppm P and 8.0 ppm SO_4-S.

[f] Soil test 5.0 ppm P and 9.0 ppm SO_4-S.